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Contact lens

P R Chatterjee
Regional Institute of Ophthalmology, Medical College, Calcutta-700 073, India

Abstract : The contact lens is a curved lens and is kept directly on the anterior segment of the eye ball either on the cornea or both on cornea and the sclera between the two lids. It differs from the ordinary spectacles where the lenses are supported in the frames and are about 10-12 mm in front of the cornea

The contact lens eliminates the cornea as a major refractive media and the refraction of the light rays occurs on the anterior surface of the lens. The tear fluid in between the contact lens and the cornea fills up the irregularities on the anterior corneal surface and eliminates corneal astigmatism.

Basically, there are two types of contact lenses—(1) Corneal contact lens and (2) Scleral one.

On the basis of the chemical nature, contact lens is of three types (a) hard, (b) semi soft, (c) soft one. The hard one is made of plastic acrylic material—Poly Methyl Meth Acrylate a derivative of acrylic acid. The soft and semi soft one are made out of silicon base and through them gas permeable takes place.

Contact lens is recognised as an essential and important visual aid in a variety of eye conditions to combat visual handicap and corneal blindness.

To calculate what correction should be incorporated in a contact lens, the corneal anterior surface (i.e. base curve) will be measured by an instrument called keratometer. This paper describes the various types of contact lenses ; their optics, relative advantages and disadvantages and conditions of utilisation.

Keywords : Contact lens, types, optics, indications, contraindictions and side effects.

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I. Introduction

Contact lens is a thin curved lens, directly floating on the anterior segment of the eye ball either on the cornea or both on the cornea and sclera between the two lids. It differs from the ordinary spectacles where the lenses are supported in frames and are about 10-12 mm in front of the cornea.

Historical literature reveals, Leonardo da Vinci was the first person who conceived the idea of contact lens in 1508 A. D. by neutralising the corneal refractive power by immersing the eye in a hollow glass bowl. Since then, efforts were made to improve the type, quality and utility of contact lenses till 1948 when plastic contact lens was introduced. W Sohnges first used the micro corneal

contact lens in 1954. 1960 saw the use of hydrophilic contact lens. Subsequently, soft, semisoft and extended wear contact lenses came into use.

Contact lens eliminates the cornea as a major refractive media and the refraction of the light rays occurs on the anterior surface of the contact lens. The tear fluid in between the contact lens and the cornea fills up the irregularities on the anterior surface of the cornea and thereby eliminates corneal astigmatism.

2. Type of contact lenses

Basically there are two types of contact lenses,

(a) Corneal contact lens—where the lens is on the cornea.

(b) Haptic or Scleral contact lens—here the lens is both on the sclera and cornea.

The latter is not used widely and is almost obsolete now.

The contact lenses can be further classified into three types on the basis of their chemical nature,

(a) Hard contact lens—It is made of plastic acrylic material—Poly-Methyl-Meth-Acrylate (P.M.M.A.).

(b) Soft contact lens—It is made of Hydroxy-Ethyl-Meth-Acrylate (H.E.M.A.) or related polymers e.g. Ethylene-Glycol-Dimethyl-Acrylate (E.D.M.A.), Poly-Vinyl-Pyrrol-Iodine (P.V.P.) etc.

(c) Semi-soft contact lens—It is made of either Cellulose-Acetate-Butyrate (C.A.B.) or Silicone cross linked with Poly-Methyl-Meth-Acrylate (P.M.M.A.). This variety is also called "Rigid Gas Permeable Contact Lens."

2.1. *Hard contact lens :*

It is rigid, durable and easy to clean. It may be stored in wet or dry condition. It can retain its shape althrough. Its prolonged use leads to deprivation of corneal oxygen and ultimately it causes corneal oedema. This is called "Over Wearing Syndrome".

2.2. *Soft contact lens :*

It is not rigid, rather soft and not durable. It is always stored in wet condition. It is a larger lens of about 13 mm diameter. It has unique property of retaining its shape despite retaining a large volume of water or fluid within it. Unlike hard one, its curvature may change if there is a high degree of corneal astigmatism. Oxygenation of the cornea is not a problem unlike with the hard variety. May be worn continuously for days, weeks or months. It causes least irritation.

It has the tendency to accumulate mucous, protein and mineral deposits on it—resulting in corneal infection, corneal ulceration and even complete loss of sight. Cleaning, disinfection and sterilisation of soft contact lens at regular intervals is a must.

2.3. Semi-soft contact lens or Regid Gas Permeable contact lens :

It has varying degrees of oxygen permeability. It interferes less with corneal epithelial metabolism. So, chance of corneal oedema is much less as compared to hard one on prolonged use. Incidence of corneal infection is very negligible in comparison with soft one. It may be stored in dry or wet condition. Cleaning is easier than with the soft variety.

So this type of contact lens is much more acceptable because of less side-effects. Hence its popularity with contact lens consultants is increasing.

3. Optics of contact lens

(A) Correction of ametropia with contact lens is accomplished by a physical alteration of the vergence power of the eye in the plane of the cornea.

(B) This is achieved by the abolition of the anterior surface of the cornea, as a first refracting surface of the eye and substituting it by a new curvature produced by anterior surface of the contact lens.

(C) Close adherence of the contact lens and the thin film of tears overing it to the anterior surface of the cornea in effect reduces the eye optically to a new single spherical refracting surface (S.S.R.S.)

(D) So, correction of the ametropia is due to the back vertex power of the fluid lens in air. As it is thin, power will be :

$FLA + FLP = K,$

FLA = Fluid lens anterior

FLP = Fluid lens posterior

K = Ocular refraction

$$FLA = \frac{n - 1}{r_A},$$

where

n = Refractive index of fluid lens

1 = Refractive index of air

r_A = Radius of curvature of anterior surface of fluid lens

$$FLA = \frac{1.336 - 1}{r_A}$$

$$r_A = \frac{0.336}{FLA} \text{ i.e } \frac{0.336}{K - FLP}$$

$$r_A = \frac{0.336}{K - (-C)} \text{ in meters}$$

where

$FLP = -C$.

C = Corneal power as measured by keratometer.

As r_4 is radius curvature of the anterior surface of the fluid lens, it is also the posterior radius curvature of the contact lens (Duke-Elder 1972 and Girard 1971).

3.1. Correction of refractive error :

To correct myopia with contact lens, power of the eye as S.S.R.S. is decreased by increasing the effective radius of curvature of the new cornea.

Conversely, in hypermetropia, the radius of curvature of the new cornea is decreased, resulting in increased power of the eye as S.S.R.S.

Correction of the astigmatism with contact lens is limited to the correction of the astigmatism from irregularities of the anterior surface of the cornea (Girard 1971).

3.2. Differences between contact lens and spectacle lens in correction of ametropia :

1. Contact lens effects its correction mainly by physically changing the power of the eye.

2. Spectacle lens does not directly affect the power of the eyes. It causes a linear shift in the cardinal points of the lens-eye combination.

3. In high myopia, contact lens increases the size of the image by 15% as compared to corrected spectacle lens at a vertex distance (13 mm).

4. High hypermetropic (Aphakic) eye tolerates reduced image with contact lens (7%) better in comparison with spectacle lens (30% large) (Girard 1971).

4. Contact lens-vs-intra ocular lens in uniocular aphakia

(a) Contact lens is easy to wear and remove in younger age group.

(b) No operation and no microscope is required to fit contact lens.

(c) Intra ocular lens needs surgical expertise. It is costly.

(d) Incresed anisokonia and less binocular vision with contact lens as compared with intra ocular lens.

(e) Long-term effect of intra ocular lens in to the human eye is not known till date.

4.1. Contact lens is an essential and important visual aid in the following conditions :

(i) High myopia and progressive myopia specially in younger age groups.

It is well established that contact lenses not only improve visual acuity significantly in high myopes, but also benefit them either by reducing or arresting

the progress of myopia in many cases. This fact has also been proved in a study entitled, "Efficacy of Contact Lens in high myopes" conducted at our Department (Nag 1988).

(ii) Unilateral aphakia and aphakia in younger age group.

The visual improvement was best recorded with hard contact lenses, better with semi soft one and least with soft lenses (Sharma et *al* 1983).

(iii) Irregular astigmatism and keratoconous.

(iv) Defective vision due to corneal opacities.

(v) Anisometropia, aniridia, albinism and nystagmus.

(vi) Softer variety of contact lenses are used *Therapeutically* in

(a) Dry eye syndrome due to any cause.

(b) Exposure keratitis, corneal injuries and as a splintage after corneal surgery.

Besides, soft lenses have been soaked in various drugs and used for applying high drug concentration to the cornea.

(vii) Contact lens may be used in :

(a) Patients, actors, actresses to change the colour or appearance of the eyes on the screen.

(b) Contact lens shell is used in blind eye having dense corneal opacity.

(viii) Diagnostic use : The contact lens can be used in diagnostics for

(a) Gonioscopy ;

(b) Slit lamp funduscopy etc.

5. Contra-indications to the use of contact lens

(a) Excessive watering due to any cause.

(b) Absence or insufficient tear. Now-a-days soft contact lens is used with artificial tear.

(c) Allergy to different types of contact lenses.

(d) Occupational conditions—e.g. working in dusty atmospheres, exposure to chemical fumes and frequent exposure to foreign body—these are relative contra-indications.

5.1. Side-effects after using contact lenses :

Redness, corneal abrasions, irritation and corneal ulcer. Corneal oedema with prolonged use of contact lens, mainly with hard contact lens. Soft contact lens of any variety may produce corneal ulcer, if the contact lens is not properly sterilised and disinfected.

All these side-effects are due to either prolonged wearing beyond the schedule or faulty fitting or improper sterilisation and disinfection of the contact lens (mainly soft contact lens), or wetting and cleaning solutions.

6. Composition of contact lens solutions commonly used :

(a) Benzalkonium chloride : (0.002% to 0.004%).

(b) E.D.T.A. sodium : (0.1%).

(c) Chlorabutanol : (0.1%).

(d) Thimerosal : (0.002% to 0.002.5%).

(e) Chlorhexadine gluconate : (0.0025%).
pH varying from 6.85 to 8.65.

In a study on contact lens solutions by Dada and Mehta (1988), it was found that the contact lens cleaning and wetting solutions available in our country were not upto the mark and the constituents of the solution and pH were not properly adjusted.

6.1. Tolerance of the contact lens :

Soft variety mainly extended wear contact lens has excellent tolerance, semisoft has good tolerance while hard contact lens has comparatively less tolerance due to lid sensation, oily smear on the lens surface and "over wearing syndrome". Hard lens usually has poor tolerance, specially in children and elderly individuals.

7. Conclusions

It may be concluded that the following factors are to be emphasized prior to the use of contact lens :

(a) Proper fitting of the contact lens by the specialist.

(b) Motivation and tolerance of the patient.

(c) Safe lens material and excellent manufacturing technique.

(d) Reliable sterilisation methods.

(e) Wetting and cleaning solutions—their sterility, correct composition and proper pH.

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